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Wasana Sedera
Queensland University of Technology

Guy Gable
Queensland University of Technology

Michael Rosemann
Queensland University of Technology

Robert Smyth
Queensland University of Technology

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Wasana Sedera
Queensland University of Technology
School of Information Systems
w.sedera@qut.edu.au

Guy Gable
Queensland University of Technology
School of Information Systems
g.gable@qut.edu.au

Michael Rosemann
Queensland University of Technology
School of Information Systems
m.rosemann@qut.edu.au

Robert Smyth
Queensland University of Technology
School of Information Systems
r.smyth@qut.edu.au

Abstract

Business process modeling has gained widespread acceptance and is employed as a design and management technique for a wide variety of purposes. While there has been much research on process modeling techniques and corresponding tools, there has been little empirical research into the important factors of effective process modeling, and the post-hoc evaluation of process modeling success. This study is the first that attempts to identify process modeling success factors and measures. This paper reports on the consolidated research findings of three case studies conducted in leading Australian organizations. It reports on an empirically derived Process Modeling Success model with success factors and success measures of business process modeling.

Key words: Business process modeling, critical success factors, success measures, case study method

1. Introduction

Organizations require flexibility and rapid responsiveness to address business challenges through better understanding of their business processes (Davenport, 1993; Hammer and Champy, 1993). Process modeling is widely used within organizations for this purpose; as a 'method' to increase the awareness and knowledge of business processes, and to reduce the associated organizational complexity. Process modeling is an approach for visually depicting how businesses conduct their operations; defining and depicting business processes including entities, activities, enablers and the relationships between them (Curtis, Keller and Over, 1992; Gill, 1999, p.5).

Process analysis and design has become a standard part of corporate change initiatives (Curtis et al., 1992). Success and failure of modeling is thus a critical element for these initiatives, since its results often lead to the implementation of new processes, organizational structures and subsequently IT systems. However, little attention has focused on deriving guidelines on 'how-to' conduct process modeling effectively or on the post-hoc evaluation of actual process modeling projects. This study aims to address this knowledge gap and aims to address two main research questions:

- ***How can the success of a process modeling initiative be measured?***
- ***What are the critical success factors of process modeling?***

This is the *first* study that attempts to empirically measure the success of process modeling initiatives. The study unit of analysis is the 'process modeling project'. In the context of this study “the process modeling project is a success if it is *effective and efficient”*. A Process modeling project can be considered *effective* to the extent it fulfills its objectives. A process modeling project can be considered *efficient* to the extent that process modeling activities are completed within the allocated time and budget. The study aims to evaluate multiple independent variables (hereafter referred to as success factors) and multiple dependent variables (hereafter referred to as success measures) pertaining to the success of process modeling projects. Success factors are those elements that are essential for the effective and efficient achievement of the modeling-project aims. Success measures provide an indication of the state of the project after completion. The study’s research design employs a two-phase, multi-method approach: (1) a multiple case study (qualitative) to *build* the model, and (2) a survey (quantitative) to *test* the model. This paper reports on the first phase and presents the multiple case study findings.

The remainder of the paper will first present a brief literature review followed by the multiple case study design employed. Next, the case studies are briefly introduced, followed by discussion of the findings. The paper concludes by summarizing the study contributions, limitations and recommended follow-up.

2. Literature Review

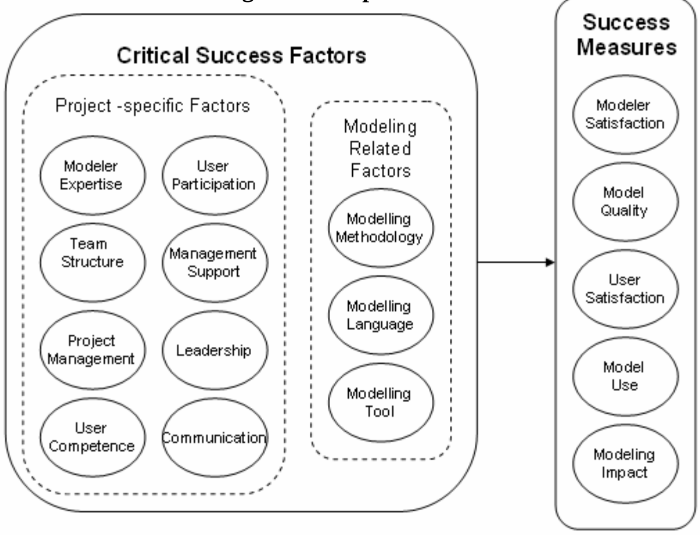
Past studies have described and justified the use of process modeling at various stages of systems implementations. Process modeling is used for (1) model-based identification of process weaknesses, (2) adapting ‘best business practices’, (3) the design of a new business blueprint (as a form of documentation and communication, and (4) end-user training (Gulla and Brasethvik, 2000; Becker, Rosemann and Schutte, 1997; Rosemann, 2000; Curtis et al., 1992; Bartholomew, 1999). The literature also reports how process modeling has been employed in a range of different applications. Some examples are activity based costing, supply chain management, customer relationship management, total quality management, workflow management, knowledge management, and simulation (Becker, Rosemann and Von Uthmann, 2000, Rosemann, 2000; Curtis et al., 1992). Information Systems (IS) success factor studies, especially those reporting on large-scale multimillion dollar implementations such as Enterprise Systems projects, explicitly and implicitly suggest the importance of process modeling and its contribution to the success of these projects (Wreden, 1995; Forsberg, Ronne and Vikstrom, 2000; Bancroft, 1998; Clemons, Thatcher and Row, 1995; Parr, Shanks and Darke, 1999). Kesari, Chang and Seddon (2003) specifically state the advantages of process modeling, in Information Systems projects and classify process modeling benefits into three main categories. These include ‘Documentation benefits’ (a common language with clients, a means for basic communication, and having a flexible template); ‘Design benefits’ (understanding the current business processes, generation of new possibilities and a means of planning for the project implementation), and ‘Use benefits’ (visual representation of processes, supporting the iterative development process of systems, and time efficiency).

Most of the published work pertaining to process modeling describes how to use certain modeling tools (e.g. Scheer, 1998a) or describes the application of modeling languages (e.g. Rosemann and zur Mühlen, 1997). Some articles provide descriptions in the form of case narratives based on reflective learning from past projects (e.g. Scheer, Abolhassan, Jost and Kirchmer, 2002). New streams of process modeling research, such as the use of reference process models, are now emerging (e.g. Rosemann and Chan, 2000; Scheer, 1998b). One framework deemed relevant and useful for the process modeling context is the Guidelines of Modeling (GoM) framework (Becker et al., 2000). It presents six dimensions of quality that can be used to evaluate a process model. However no empirical testing of the framework has been reported to date. Overall, empirical studies on process modeling are scarce and, to the authors' best knowledge, there have been no studies that identify and describe essential elements that should exist in a process modeling project or how to evaluate the overall success of a process modeling project. Addressing this gap has been the motivation for this study.

3. Research design

A comprehensive literature review was conducted to identify candidate process modeling success factors and measures. An a priori process modeling success model was derived from the literature, and a multiple case study design chosen to further validate the a priori model. This 'model building' phase reported herein will be followed by a survey to test the model ('model testing'). The case study and survey methods, when combined, are complementary, each offsetting limitations of the other (Gable, 1994).

Figure 3.1: A priori model



3.1 Deriving the a priori model

An a priori model was derived from review of the literature, that model ostensibly reflecting a complete set of critical success factors and success measures. Figure 3.1 depicts the resultant a priori model and Table 3.1 defines its constructs. The model does not purport to reflect causality among the model constructs, but instead only identifies the overall crucial success factors and overall success measures of process modeling.

Critical success factors within the context of this research can be defined as those key areas where 'things must go right' in order for the process modeling project to proceed effectively and conclude successfully (following Mc Nurlin and Sprague, 1989, p. 97). Owing to the lack of theoretical and empirical evidence of process modeling critical success factors, a review of related literature sought to identify analogous factors of success. Domains explored included (1) business process modeling; (2) software engineering and conceptual modeling success; (3) information model quality features; (4) business process reengineering and Enterprise Systems success; and (5) Information System success. Sedera, Rosemann and Gable (2001) report in detail on the identification and justification of the selected analogous domains, and the rational for success factor adoption.

Preliminary analysis of factors extracted from the literature suggested 11 candidate success factors (see Figure 3.1). These factors were broadly grouped within two categories; 'modeling related factors' (factors that were specific to process modeling) and 'project-specific factors' (factors that are common to most IS projects). Both these categories were investigated, with the aim of obtaining a holistic view on those factors that influence the level of process modeling success experienced. Table 3.1 includes brief definitions of the 11 success factors and 5 success measures of Figure 3.1.

Table 3.1: Defining the a priori constructs

Independent variables – Critical Success Factors
Modeling Methodology: A detailed set of instructions that describes and guides the process of modeling.
Modeling Language: The grammar or the "syntactic rules" of the selected process modeling technique.
Modeling Tool: The software that facilitates the design, maintenance and distribution of process models.
Modelers' Expertise: The experiences of the process modelers in terms of conceptual modeling in general and process modeling in particular.
Modeling Team Structure: The 'infrastructure' that should exist in a successful process modeling team, such as an appropriate mix of internal and external members, representatives from all modeled business units, team leadership and vision.
Project Management: The management of the process modeling project including defining the project scope, aims, milestones, and plans.
User Participation: The degree of input from users, for the design, approval and maintenance of the models.
User Competence: The amount of knowledge the users have about the modeled domain and the modeling procedures.
Top Management Support: The level of commitment by senior management in the organization to the process modeling project, in terms of their own involvement and the willingness to allocate valuable organizational resources.
Leadership: (a.k.a. project championship) The existence of a high level sponsor who has the power to steer the project, by setting goals and legitimate changes.
Communication: This describes exchange of information (feedback and reviews) amongst the project team members and the analysis of feedback from users.
Dependent variables - Success Measures
Modeler satisfaction: The extent to which the modelers (those who design the process models) believe process modeling fulfills the objectives that underlay the modeling project.
Process model quality: The extent to which all desirable properties of a model are fulfilled to satisfy the needs of the model users in an effective and efficient way.
Model use: The extent to which the process models are applied and utilized.
User satisfaction: The extent to which users believe process modeling fulfills the objectives that underlay the modeling project.
Process impact: Measures the effects of process modeling on the process' performance. Here, the 'process' refers to the processes or functions to which process modeling is being applied.

'Success' is a complex multi-dimensional phenomenon. Hence, having a correct and complete set of measurement dimensions is important (Garrity and Sanders, 1998, p.31; Kallenis, Lycett and Paul, 1998). Thus, during the a priori model building phase an attempt was made to identify major IS success frameworks and marry these with the study's context [e.g. De Lone and Mclean (1992); Garrity and Sanders (1998); Seddon (1997); Myers, Kappelman and Prybutok, (1998); Goodhue (1992)]. Due to the lack of any reported process modeling success studies, IS success frameworks were sought as a proxy to identify candidate process modeling success measures. Sedera, Rosemann and Gable (2002) describe and justify the identification, re-specification and adaptation of these success frameworks and extracted measures, relating them to the process modeling context. Five a priori process modeling success measures were identified through this process (see Figure 3.1).

3.2 The Use of Case Studies

The case study method emphasizes qualitative analysis. It enables the researcher to conduct the study in a natural setting and generate theory from practice, simultaneously enabling the researcher to understand the nature and complexity of the phenomenon investigated (Benbasat, Goldstein and Mead, 1987; Yin, 1994). It is a scientific and recommended way to research an area in which few previous studies have been conducted (Lee, 1989; Yin, 1994). The single case study is appropriate when the researcher wants to identify new, previously un-researched issues, while, a multiple case design is desirable when the intent is to build and test theory (Yin, 1994). A single pilot-case study and subsequent multiple case studies were employed in this research, the primary goal being to instantiate the candidate success factors and measures identified from the literature review.

3.3 Case Study Design

In attention to several known potential weaknesses of the case study method (Benbasat et al., 1987), a case study protocol[1] was designed, carefully documenting all procedures relating to the data collection and analysis phases of the study.

Qualitative data collection mechanisms including in-depth interviews, and content analysis of existing documentation were used to collect 'rich' evidence about the process modeling projects. Observations and documentation were used only to augment and corroborate interview data, which was the main input to data analysis. Whenever possible, interviews were conducted with multiple stakeholders in the process modeling project(s), namely the modelers and the project sponsors. The interviews were semi-structured, each completed within 60-90 minutes. All interviews followed the same structure and format (as pre-specified by the case protocol), commencing with an open discussion on perceived success/failure factors and measures of process modeling success in relation to the selected project. Subsequently, the individual constructs of the a priori model were introduced (for the first time), and the respondents' opinions on the overall relevance and importance of these constructs were sought. This approach enabled the researchers to obtain new ideas to enhance the model, while simultaneously validating existing a priori constructs.

All relevant data (interview transcripts, research memos, sample process models, documented modeling guidelines, etc.) were maintained in a 'case database' (Yin, 1984; Mile and Huberman, 1994) and close linkages between the research questions, evidence, interpretations and conclusions were maintained throughout the analysis. The qualitative data analysis tool NVivo 2.0 was utilized during this phase to capture, code and report the findings of the case study. Reliability was enhanced through the use of a detailed case protocol and a structured case database. Construct validity was strengthened within the study through the use of multiple sources of evidence, establishing a chain of evidence with a well-structured case database, and by having the key informants review draft case study reports at the completion of data analysis at each case site. Predictive validity was increased by the application of prior-established data analysis techniques such as pattern matching and explanation building (Yin, 1994). External validity, or extensibility of the findings, has been improved to a certain degree through the conduct of multiple cases studies.

4. Introducing the case studies

Case studies were conducted of nine process modeling projects (the process modeling project is the unit of analysis) in three large Australian organizations: Queensland Rail, Queensland Treasury, and Telstra.

Queensland Rail (QR) is a Queensland State Government owned corporation that provides transport and logistics business solutions to a diverse range of customers throughout the State, Australia and overseas. Business process modeling is used within QR for a variety of purposes. Over a period of four months (Jul-Nov 2002), 18 interviews/meetings were conducted with modelers and project sponsors involved in 4 process modeling projects within

[1] A copy of the case protocol can be obtained from the principal author upon request.

QR. Over 30 project-related documents (e.g. project charters, business cases, modeling related procedures, project management documentation etc.) were analyzed in detail.

Queensland Treasury provides core economic and financial policy advice to the Queensland Government, and assists the government in managing the State's finances, including the preparation and oversight of the budget to meet community needs. Over a 4-week period (Apr-May 2003), 4 detailed interviews and over 10 different types of documents were assessed in relation to a single detailed process modeling project at Queensland Treasury.

Telstra is a semi-government telecommunications organization with a 100-year history of providing telecommunications services to the whole of Australia. Telstra competes in a very competitive global market, and is continuously revising its strategies and business processes. Small- and large-scale projects have been initiated within Telstra for the continuous improvement of its products and services. Process modeling has played a significant role in many of these corporate initiatives. Four process modeling projects were analyzed over a period of two months (Jun-Aug 2003). Six key respondents were interviewed at 11 meetings, and a range of project related documents were analyzed in detail.

5. Multiple case study Findings

Explicit or implicit counts are often reflected in qualitative analyses when judgments are made. For example we "identify themes or patterns that happened a number of times and that consistently happen a specific way" (Miles and Huberman, 1984, p. 215). Analysis of the case study data was conducted mainly by coding the data (through the use of NVivo 2.0), thereby yielding counts and data points that were then analyzed further.

A predefined set of codes ["Codes are tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study"; Miles and Huberman, (1984, p.55, 57)] was derived as a starting point. These codes were refined, as the analysis evolved. A tree like node structure was initially created within NVivo to depict the success factors and success measures of the a priori model. The coding of the interview data was then conducted in three phases. Phase 1; coded any direct or implied existence of the constructs (of the a priori model) within the data, simultaneously identifying any new constructs. Phase 2; *analyzed* the information already coded within phase 1, (extracting the information already coded under each of the constructs) to confirm the appropriateness with the categorization. Furthermore, the codes assigned to the data were refined to distinguish between citations that indicated mere existence of the constructs, versus those that specified the criticality of the construct. Phase 3 conducted [2]*in-vivo* coding, identifying the key words stated under each construct as a means of identifying potential sub-constructs (which would be input for the design of the subsequent survey, hence, the results of this phase of coding are not discussed in this paper). Table 5.1 depicts the primary consolidated summary results of the coding phase.

Table 5.1 summarizes the total number of *general* citations (each time the construct was merely mentioned) within each interview transcript. The primary goal of this analysis was: (a) to evaluate the sufficiency of the set of model constructs, and (b) to evaluate the necessity of each model construct. Table 5.1 reflects 16 Success Factors (F1-F16) and 9 Success Measures (S1-S9). F1-F11 are the starting 11 success factors of the a priori model while F12-

[2] A method of coding available through NVivo, in which the selected document text becomes the title of a new node, created to hold that text.

F16 are new independent variables identified through the case studies. S1-S5 are the starting 5 success measures of the a priori model while S6-S9 are new success measures identified through the case studies. The column between the factors and measures (titled "Case/Project Respondent") depicts the stakeholders who were interviewed within each project.

In addition to analyzing the general citations for each construct, we also[3] (a) conducted redundancy checks with [4]'matrix intersection and difference' searches through the NVivo tool, and (b) analyzed each construct against its general citations and those instances in which it was specifically stated as important for a successful process modeling initiative (hereafter referred to as *specific* citations).

Redundancy checks enabled the researcher to identify possible instances where two or more constructs overlapped each other, and when potential *sub*-constructs were incorrectly depicted as core constructs in the a priori model. The tool's (NVivo 2.0) capacity to maintain a chain of evidence with its provision to move back and forth from the summary matrixes to the original transcripts and memo notes in the case database aided the researchers to carefully analyze and justify modifications to the model, raised through these redundancy checks.

Gathering citations which merely mentioned a construct and comparing these with the instances that specifically stated its importance, was used to justify the criticality or necessity of each construct. These 'specific' citations were analyzed in conjunction with the general citations and redundancy matrixes as further evidence when deciding the inclusion/ exclusion and merging of a priori constructs for the re-specified model. The following section describes the process of deriving the re-specified model.

5.1 Respecifying the independent variables: the Success Factors

'**Top Management Support**' **(F1)** was consistently cited across interviewees (modelers and project sponsors), across projects, and across case sites. However, overlap was perceived across the case sites with other a priori constructs such as Leadership. Close analysis of the interview data suggested that aspects of management support, such as funding and management participation, played a significant role in successful modeling projects. Thus, Top Management Support was kept as a separate construct, and the overlap with other constructs was noted, to guide subsequent model operationalisation.

The respondents consistently cited **Leadership (F2)**, arguing its relevance and importance as a critical success factor of process modeling projects. However, as suggested, there was substantial overlap with the data coded under 'Top Management Support' (this became evident after a matrix intersection search through NVivo), respondents often referring to the *'need to have support for the initiation of the project'* and '*support within the major decision making of the project*'.

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[3] Complete evidence of this data analysis results (such as sample citations and resulting matrices) were not included due to space constraints, but can be provided upon request from the principal author.

[4] Matrix Intersection search is a type of Boolean search made available through NVivo. It takes one feature from each collection at a time, and finds passages in the documents or nodes, which contain both.

Matrix Difference search is a type of Boolean search made available through NVivo. Taking one feature from each collection at a time, it finds passages in the documents or nodes having the feature from the first collection but not the second, returning a table of results.

Table 5.1: Consolidated summary results of the coding phase
(A summary of generic citations, categorized by case study, project and respondent, on each model construct)[5]

Success FACTORS														Success MEASURES								
A Priori								New					Case / Project	A Priori					New			
F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	Respondent	S1	S2	S3	S4	S5	S6	S7	S8	S9
Team structure	User competence	Modeler expertise	User participation	Communication	Modeling language	Modeling method	Modeling tool	Complexity	Importance	Culture	Information Resources	Need		Modeler satisfaction	Model quality	Model use	User satisfaction	Process modeling impact	Usefulness	Individual impact	Process impact	Others
													Queensland Rail									
													P1: Work request automation project: Technical Services Group (TSG)									
4	3	2	6	2	2	5	3	4				3	Internal Modeler	0	0	1	1	0				
													P2: Freight booking system project: Infrastructure Services Group (ISG)									
2	2	4	6	1	0	2	4	2		3			Internal Modelers	0	0	0	1	0				
													P3: Train control transition project : across Queensland Rail									
2	3	3	2	2	1	1	2						Internal Modeler	0	2	4	0	1				
4	1	7	7	6	0	3	5						Project sponsors	0	0	3	0	0				
													P4: Rail Supply Chain Optimization (SCOR) Project: supply division									
1	1	2	2	3	2	1	2	1					Internal Modelers	1	1	2	0	1				
0	1	2	1	1	2	0	1			1			Project sponsor	0	0	3	0	4				
13	11	20	24	15	7	12	17	7	0	4	0	3	OVERALL SITE analysis	1	3	13	2	6				
													Queensland Treasury									
													P1: K-economy project									
1	-	1	2	5	5	1	6	2	2	3	1		External Modeler 1	1	3	5	2		2	2	1	Achieved objectives - 3
2	2	3	3	2	2	6	5	2	3	2	-		ExternalModeler 2	0	5	4	1		2	1	0	Achieved objectives - 2
3	1	5	9	2	4	3	2	3	3	1	-		Internal Modeler 3	1	3	4	3		1	5	4	Achieved objectives - 1
7	1	2	6	4	3	4	5	5	-	1	-		Project sponsor	1	3	2	1		5	0	6	Achieved objectives - 3
13	4	11	20	13	14	14	18	12	8	7	1	0	OVERALL SITE analysis	3	14	15	7		10	8	11	9
													Telstra Queensland									
													P1: IP Telepony Assuarance project									
0	2	2	2	3	2	4	4	2	1	2	9		Internal Modeler1	1	2	1	3		1	2	1	met purpose - 1
													P2: Interim Mini-Stats Ordering Project									
1	1	7	2	5	2	2	2	2	2	2	12		Internal Modeler1	1	2	0	5		3	2	2	met purpose - 1
													P3: Payphone Faults Detection Project									
0	0	7	7	4	2	3	6	5	2	1	8		Internal Modeler1	0	0	1	1		1	0	0	
													P4: Supplimentary Worker Project									
2	1	7	2	5	0	0	1	0	0	0	6		Internal Modeler1	0	0	0	2		0	2	0	
3	4	23	13	17	6	9	13	9	5	5	35	0	**OVERALL SITE analysis**	2	4	2	11	0	5	6	3	2
29	19	54	57	45	27	35	48	28	13	16	36	3	**Consolidated TOTAL**	6	21	30	20	6	15	14	14	N/A

[5]Please contact the authors for information on the individual projects that were analyzed.

Though Leadership was at times referred to as Management Support, the phrases simultaneously referred to other sub-constructs of Management Support such as availability of funding, resources etc. This led us to conclude that Top Management Support is a multi-dimensional construct that should be included in the model, and that Leadership is a sub-construct of Top Management Support that relates to the participation and decision-making power shown by managerial staff on the process modeling project. Thus, Leadership was removed from the model and appropriate sub-constructs to compensate for the removal of Leadership were included within the Top Management Support construct.

Project Management (F3) was the most cited success factor across all three case sites (a total of 84 general citations). Data highlighted its multi-dimensional nature, with different respondents referring to Project Management sub-constructs such as Scope and Objective definitions, Quality Management, Knowledge Management, Time Management and Communication Management. However, there was significant overlap between Project Management and other constructs of the a priori model (such as Team Structure, and Communication). Following detailed analysis of this overlap, and considering those citations that specifically stated the importance of Project Management (a total of 20 specific citations of its importance), Project Management remained in the model.

While the **Team Structure (F4)** construct was mentioned within the interview data, there were only a few citations that specifically stated its importance (a total of only 2 citations across all case sites, and these two citations also overlapped with the project management citations). Furthermore, this construct significantly overlapped with other constructs such as Project Management and Communication. Given weak evidence of its existence, Team Structure was removed from the model. Similar to Team Structure, **User Competence (F5)** had few general citations (19 in total) and specific statements (6 in total) that described its low relevance as a success factor for process modeling, thus, was removed from the model.

Modeler Expertise (F6) was consistently cited as an important element of success in process modeling (16 citations specifically stating its criticality for a modeling project). However, Modeler Expertise, overlapped with other constructs – e.g. 'Communication' and 'Getting Information' (Information Resources). This suggested possible overlap with the Modeler Expertise sub-constructs which included the 'required skills', 'knowledge' and 'experience' the modeler ought to have, in order to succeed on a process modeling project. The specific citations on modeler expertise clearly stated its importance. This justified Modeler Expertise as a separate construct, thus it remained in the model and the other overlapping constructs were analyzed with care.

User Participation (F7) had consistent supporting citations across all projects and perspectives, a very clear indication of its importance as a critical success factor. However, the data suggested that respondents were referring to *Participation in general* and more specifically to the participation of the Process stakeholders (Those who have a role in the processes being model, who may or may not be model users), rather than the users, and hence this construct was redefined as **Stakeholder Participation**. It was also noted that Participation overlapped to some extent with 'Communication', and 'Getting Information' (Information Resources) (evident after a matrix intersection search through NVivo). Data coded under each of these were reviewed carefully to remove these potential redundancy issues. However, Participation remained in the re-specified model, due to the relatively strong citations that specifically stated its importance (19 specific citations in total; mostly with strong emphasis on its importance).

While the importance of **Communication (F8)** was specifically mentioned several times (45 general citations and 16 specific citations about its importance), there seemed to be a high level of overlap with the data coded under other constructs, especially Participation and Modeler Expertise. A closer analysis of the Communication construct aided in making the observation that there were two types of communication processes within a modeling project: (a) *Information sharing*; communication among the modeling team members for sharing information and (b) *Feedback*, communication between the modelers and the users to confirm the correctness of the models. The content coded under 'Feedback' was identical to the intersection between Communication and User Participation. Thus, this segment was identified as a sub-construct of User Participation rather than a separate construct of its own.

The 'Information sharing' was perceived to be an aspect that should be planned for and addressed within a good project management plan. Thus, this was included under Project Management. A matrix differences search conducted between Communication and the two re-located sub-constructs of Communication (Feedback and Information Sharing) supported the conclusion that the core aspects of communication are captured under Participation (the 'Feedback' sub-construct) and Project Management (the 'Information sharing' sub-construct). Hence, there was no need for a separate Communication construct in the re-specified model.

A new issue (or factor) "Getting Information" was raised in data gathered within the second and third case sites. We identified this as a critical success factor because of the relatively high number of citations (a total of 34 general citations and 14 specific citations that stated its importance). After careful analysis of the data gathered within the case study, this construct was re-specified as '**Information Resources' (F15)** and defined as "*those resources available to inform the modeling project*". This new construct substantially overlapped with the Participation construct. This can be explained by the fact that Participation, in the context of process modeling initiatives, was important, mainly to gather relevant information to undertake the modeling, and for reviewing the completed models. However it was made evident from the data that Information Resources emphasized the *<u>state</u> of information available*, while Participation emphasized the *<u>process</u> of gathering information*. Thus, both constructs were maintained in the re-specified model.

All three initial modeling-specific constructs, the **Modeling Tool (F11)**, the **Modeling Technique** (a.k.a. Modeling Language) **(F9)** and the **Modeling Guidelines** (a.k.a. Modeling methodology) **(F10),** remained in the model. It was interesting to note that although they all had citations to support their relevance and importance in a process modeling project, they all scored lower overall general citations than the project-specific factors Participation, Project Management and Top Management support (see Table 5.1– last row). This, indicates the overall relative importance that project-specific factors play within a process modeling project.

Five new success factors were identified across the case studies (see table 5.1 Columns F12-F16). The most significant of these, 'Getting Information' (Information Resources) was discussed earlier. Two new constructs were identified from the first case site: '**Need**' **(F16)** and '**Culture**' **(F14)**. The 'Need' construct captured '*how important the overall initiative is*' (in other words, what motivated the process modeling project); 'Culture' was '*the organizational readiness to accept and participate in a modeling initiative*'. The 'Need' construct was later redefined with some reference to past literature (e.g. Seddon, 1997), to '**Importance' (F13)**, which was defined as 'the criticality of the process modeling project to the organization'. This new 'importance' construct was further justified in the succeeding case studies and was included in the modified model. However, no strong evidence was collected from any of the case studies to justify having 'culture' as a separate construct in the modified model (only 4 citations had mentioned its importance). The data indicated that culture would be influential for the "*initiation of a modeling project rather than for the 'success' of the project*". Furthermore, 'culture', was a reflection on the Leadership and Top Management Support constructs. Thus, it was not included as a separate construct in the modified model. '**Complexity**' **(F12)** was another new construct, which was identified from the very first case study. Initially, it was defined as *'the complexity of the processes being modeled as well as how the detailed modeling was to be done'*. This construct was further justified in the succeeding case studies and was later re-specified and re-defined as *"the many different features of the processes modeled"*, capturing the complexity of the processes being modeled. Based on this analysis, both 'Complexity' and 'Importance' (previously known as 'need') were included in the re-specified process modeling success model, as moderating variables. They were hypothesized as moderating variables as (a) both Complexity of the process and the Importance of the project were not things that one can influence or change (whereas all other independent factors of the model were influential to some extent) and (b) their existence seems to have an impact on other success factors such as Top Management Support, Project Management, Modeler Expertise, Modeling Tool and Modeling Technique etc. (evident with a matrix intersection search through NVivo2.0).

5.2 Respecifying the dependent variables: the Success Measures

The data analysis strategies employed for the success measures were the same as those for the success factors. However, it was noted that the amount of data coded under the success measurement nodes was relatively low compared to that for the success factors. Respondents were often not very familiar with concepts of 'success measurement', especially within the context of process modeling.

Modeler Satisfaction (S1) was the least supported success measure, with relatively fewer general citations. There were citations that specifically denoted its irrelevance as a success measure (3 in total – 50% of total general citations). Respondents referred to its potential for being biased, especially when respondents are modelers, and suggested it is unsuitable as a success measure. Thus, it was removed from the modified model.

Both **Model Quality (S2)** and **User Satisfaction (S4)** constructs were supported by the case studies, always scoring a relatively higher number of general citations and specific citations (Model quality 7, User satisfaction 13) discussing its importance. Thus, both Model Quality and User Satisfaction were integrated as success measures in the modified model. **Model Use (S3)** received the highest number of general citations (30 in total) However, very few respondents supported its *relevance* as a success measure and they commonly agreed on the difficulty in effectively measuring the 'level of model use', thus denoting that it was not a suitable measure for Process modeling success. Furthermore, this construct significantly overlapped with the new Usefulness, Individual Impacts and Process Impacts constructs (evident from a matrix intersection search). Thus, Use was removed from the modified model.

Earlier case study analysis raised concerns about the 'Use' construct (i.e. in terms of difficulty of measurement and irrelevance to the context of process modeling). Similar concerns are raised in the IS success literature. Seddon propose usefulness in place of use (Seddon, 1997). Thus, **Usefulness (S6)** was integrated into the modified a priori model for the latter case studies (after the Queensland Rail project analysis were completed). While there were a significant number of citations on usefulness (15 in total from just 5 investigated process modeling projects), it also showed significant overlap with the impacts constructs, when an intersection search was conducted through NVivo. Thus, it was removed from the modified model

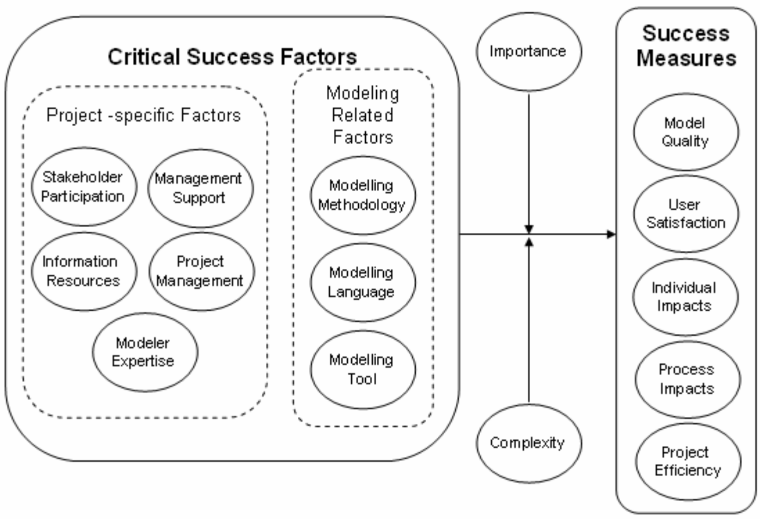
The a priori '**Process Modeling Impacts**' **(S5)** construct was decomposed into two separate constructs after the data analysis of the first case site. The decomposition consisted of "**Individual Impacts**" **(S7)** (which refers to how process modeling has influenced the process stakeholders; those who have a role in the processes being modeled) and "**Process Impacts**" **(S8)** (which refers to the overall effect of process modeling on the processes modeled). This was initially identified within the analysis of Queensland Treasury. This decomposition was further tested within the Telstra projects and was supported (most impacts related citations were around the two main themes of *impacts to individual*s and *impacts to the processes* being modeled). Thus, the single a priori 'Impacts' construct was replaced by the two decomposed constructs of, 'Individual Impacts' and 'Process Impacts', in the modified model.

Other potentially useful success measures were carefully explored from the data collected on the case studies. The degree to which the modeling activities fulfilled their initial objectives and met intended goals was raised as an important measure at some instances within the case studies. Citations often referred to the process modeling project's ability to maximize invested resources in relation to the obtained outcomes. While this was considered important, it did not 'fit' within any of the existing measurement constructs. Thus a new measurement construct "Process Efficiency" was later added to cater for this, and was defined as "*the process modeling project's ability to maximize the invested resources in relation to the obtained outcomes*".

5.3 *The overall re-specified Process Modeling Success model*

Figure 5.1 summarizes the re-specified success model derived from the multiple case studies. In summary, analysis of the success factors resulted in: (a) Leadership, Team Structure, User Competence, Communication and Culture being removed from the model due to overlap with other more critical constructs and /or due to lack of evidence to support their existence as a separate critical success factor; (b) A new success factor, 'Information Resources' (Getting Information) and (c) Two new moderating variables - Complexity and Importance were included in the re-specified model, and (d) User Participation was redefined as Stakeholder Participation.

Figure 5.1: Re-specified process modeling success model



The analysis of the success measures resulted in the following insights: (a) two levels of potential process modeling impacts were identified. Process modeling impacts at the individual process stakeholder level (Individual Impacts) and process modeling impacts at the overall process level; (b) Modeler Satisfaction was removed from the model due to its potential for bias and its perceived lack of relevance as a success measure; (c) The Model Use and Usefulness constructs were removed from the model because of perceived overlap with the other measurement constructs; and (d) a new success measure; Project Efficiency was identified and integrated.

6. Study contributions, limitations and OUTLOOK

This paper reported on a process modeling success model validated through a multiple case study. The identified success factors (both modeling specific and generic factors) can be usefully applied by practitioners to plan and conduct a modeling project. The reported process modeling success model also provides a mechanism to effectively measure the effectiveness and efficiency of a modeling project. The study findings contribute to academia, by presenting a validated Process modeling success model that can be applied and tested with other modeling domains.

The study is *novel*, *factor based* and *measurement oriented*. Given the study's nature, relying on extant theory was inappropriate. The study draws heavily on referent domains to elicit the initial set of candidate success factors and measures. Attempts have been made to justify their relevance as referent fields, and case studies of the process modeling contexts were conducted to modify the model. However, the researcher is aware that the elicitation of candidate model constructs from other domains may be problematic (due to differences in context) and that the elicited list could have influenced the case study findings. The inherent weaknesses of the case study method may also have impacted the findings reported.

The study has been extended (with a quantitative model testing phase), with the aim of addressing these potential limitations. The process modeling success model reported herein has been operationalized with a comprehensive survey instrument targeting process modeling stakeholders (namely; process modelers, model users and process modeling project sponsors) at an international level. The survey was pilot tested in October 2003 and the revised version has been disseminated. Data gathered from this phase will be used to further validate the process modeling success model through quantitative analytical techniques.

7. Summary

This is the first attempt to empirically derive a process modeling success model. The study background, motivation and research questions were presented in the introduction. The paper then provided a brief literature review summarizing the nature of studies conducted in the process modeling arena, followed by an overview of the research design employed.

The study has employed a multi-method approach combining the case study and survey methods in two sequential phases. The focus and scope of this paper was on the multiple case study phase, the primary contribution being an empirically derived process modeling success model. The paper discussed the appropriateness of the case study method, followed by an introduction of the case settings and a discussion on the case results. Finally, the contributions, limitations and next steps of the research were highlighted.

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